Electronic Version
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Claims

[c1] An apparatus comprising:a switch comprising microelectromechanical elements, the microelectromechanical elements comprising:a sealed chamber containing a dielectric element; andconductors in the sealed chamber, wherein the conductors are arranged such that application of greater than a predetermined voltage causes ionization breakdown of the dielectric element to provide an electrically conductive path between the conductors.

[c2] The apparatus of claim 1, wherein the sealed chamber contains at least one of argon, neon, helium, xenon, nitrogen, oxygen, and air.

[c3] The apparatus of claim 2, wherein the sealed chamber contains a mixture of at least any two of argon, neon, helium, xenon, nitrogen, oxygen, and air.

[c4] The apparatus of claim 1, further comprising a substrate and a cover, wherein the conductors are arranged on the substrate,wherein the cover, substrate, and conductors define the sealed chamber.

[c5] The apparatus of claim 4, wherein the microelectromechanical elements further comprise sealing elements

provided between a surface of the cover and surfaces of the conductors to provide the sealed chamber.

[c6] The apparatus of claim 4, wherein the dielectric element comprises at least one of a dielectric gas and a dielectric liquid.

[c7] The apparatus of claim 6, wherein the microelectromechanical elements further comprise a dielectric layer formed over the conductors in the sealed chamber, the dielectric layer having plural openings adjacent respective conductors to provide discharge paths from the conductors through the at least one of the dielectric gas and dielectric liquid contained in the sealed chamber.

[c8] The apparatus of claim 1, wherein the microelectromechanical elements further comprise nanotube electron emitters placed on the conductors in the sealed chambers.

[c9] The apparatus of claim 1, wherein the microelectromechanical elements further comprise nanotube electron emitters placed on the conductors in the sealed chambers.

[c10] The apparatus of claim 8, wherein the nanotube electron emitters comprise boron nanotube electron emitters.

[c11] The apparatus of claim 1, wherein the conductors each has a curved side, the curved sides of the conductors facing each other across a portion of the sealed chamber.

[c12] The apparatus of claim 1, wherein the microelectromechanical elements further comprise a trigger electrode to receive a pulsed signal to cause breakdown of the dielectric element in the sealed chamber.

[c13] The apparatus of claim 12, wherein the trigger electrode is within the sealed chamber.

[c14] The apparatus of claim 12, wherein the trigger electrode is outside the sealed chamber but in the proximity of the sealed chamber.

[c15] The apparatus of claim 1, further comprising:an initiator electrically connected to the switch

[c16] The apparatus of claim 15, further comprising a local energy source to provide the predetermined voltage to the switch.

[c17] The apparatus of claim 15, wherein the initiator comprises at least one of an exploding foil initiator, an exploding bridgewire initiator, and a semiconductor bridge initiator.

[c18] The apparatus of claim 1, further comprising a substrate, the conductors formed on a surface of the substrate, wherein at least a portion of the sealed chamber is between sides of the conductors.

[c19] The apparatus of claim 1, wherein the dielectric element comprises at least one of a dielectric gas and dielectric liquid.

[c20] The apparatus of claim 19, further comprising a housing in which the switch is located, the housing providing the sealing for the sealed chamber.

[c21] The apparatus of claim 1, further comprising a radioactive material in the proximity of the switch to enhance predictability in the ionization breakdown of the dielectric element.

[c22] The apparatus of claim 21, wherein the radioactive material is provided in the sealed chamber.

[c23] The apparatus of claim 21, wherein the radioactive material comprises at least one of Chromium, Thorium, Potassium, Uranium, Nickel, and a mineral containing a proportion of Chromium, Thorium, Potassium, Uranium, and Nickel.

[c24] The apparatus of claim 21, wherein the radioactive ma-

terial comprises at least one of Thorite, Uranite, and a rock salt.

[c25] A switch comprising:electrical conductors; anda dielectric material between the conductors,wherein each of the conductors has a curved side, the curved sides of the conductors facing each other across the dielectric material.

[c26] The switch of claim 25, wherein the electrical conductors and dielectric material are microelectromechanical elements.

[c27] The switch of claim 26, further comprising a sealed chamber containing the dielectric material, the dielectric material comprising a gas.

[c28] A switch comprising:conductors;a dielectric material between the conductors; andnanotube electron emitters electrically connected to at least one of the conductors,wherein the dielectric material is adapted to break down in response to applied electrical energy provided to at least one of the conductors to provide an electrically conductive path between the conductors.

[c29] The switch of claim 28, wherein the dielectric material comprises a gas.

[c30] The switch of claim 29, further comprising a sealed chamber containing the gas.

[c31] The switch of claim 30, further comprising a dielectric layer disposed over the conductors in the sealed chamber, the dielectric layer having openings to expose respective conductors.

[c32] The switch of claim 31, wherein the nanotube electron emitters are disposed in at least one of the openings of the dielectric layer and in electrical contact with at least one of the conductors.

[c33] A method of activating a component, comprising:providing a switch having microelectromechanical elements, the microelectromechanical elements comprising a sealed chamber containing at least one of a dielectric gas and dielectric liquid, and conductors in the sealed chamber;applying an input voltage to at least one of the conductors to cause breakdown of the at least one of the dielectric gas and dielectric liquid such that an electrically conductive path extends between the conductors; andelectrically connecting the input voltage to the component through the switch.

[c34] The method of claim 33, wherein electrically connecting the input voltage to the component comprises electri-

cally connecting the input voltage to a well device.

[c35] The method of claim 33, wherein electrically connecting the input voltage to the component comprises electrically connecting the input voltage to an explosive device.

[c36] The method of claim 33, wherein electrically connecting the input voltage to the component comprises electrically connecting the input voltage to at least one of an explosive foil initiator, an exploding bridgewire initiator, and a semiconductor bridge initiator.

[c37] A switch comprising:at least two conductors; anda nanotube electron emitter to form at least part of an electrically conductive path between the at least two conductors.

[c38] The switch of claim 37, further comprising a dielectric element adapted to ionize in response to input energy to provide another part of the electrically conductive path.

[c39] The switch of claim 38, further comprising at least another nanotube electron emitter.

[c40] A method comprising: activating a switch having conductors and at least one of a nanotube electron emitter and a radioactive isotope electron emitter; andconducting electrical current between the conductors through an

electrically conducting path including the at least one of the nanotube electron emitter and radioactive isotope electron emitter.

[c41] The method of claim 40, further comprising coupling an explosive device to the switch.

[c42] The method claim 40, further comprising running a tool including the switch into a well,wherein activating the switch comprises activating the switch while the tool is in the well.